RISK DETERMINATION FACT SHEET

PROBLEM DEFINITION: What are the risks associated with the soils surrounding the OU4 Solar Evaporation Ponds, and how were the risk-based preliminary remediation goals calculated?

SOLUTION METHODOLOGY: Calculations based upon acceptable risk levels were performed in order to determine the areal extent of contaminated soils and volume of soils that required remediation. These calculations were performed following EPA Risk Assessment Guidance for Superfund Manual (Environmental Protection Agency, 1991). As specified in the Interagency Agreement (IAG), the OU4 soils require remediation if the carcinogenic risk exceeds 1.0×10^{-6}. The meaning of this number is that an individual would have a one in one million chance of contracting a cancer from OU4 exposure in excess of the probability of receiving cancer from other lifetime exposures (e.g. smoking, UV exposure). As described in detail below, the calculations were performed for surface soils under an onsite resident exposure scenario, and for subsurface soils under a construction/remediation exposure scenario.

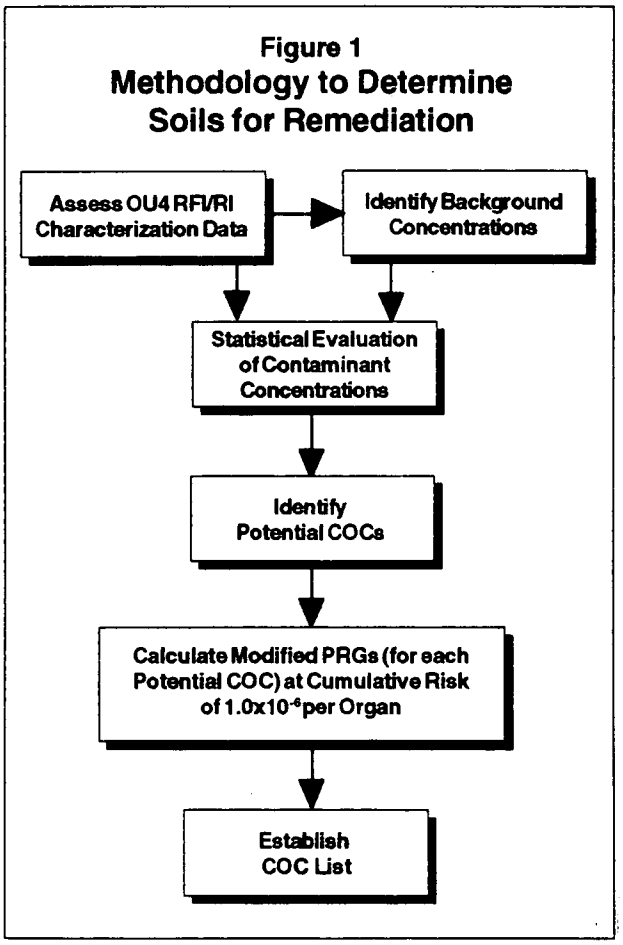
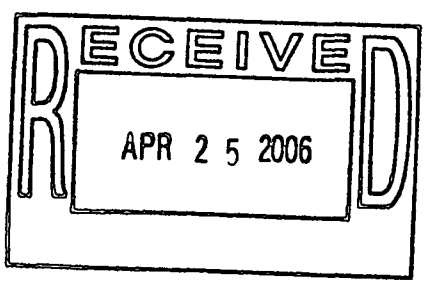


Figure 1
Methodology to Determine Soils for Remediation

The procedure for calculating risk-based preliminary remediation goals (PRGs) and subsequent volume determination of soils requiring remediation is complex, as demonstrated in Figure 1. The procedure requires a knowledge of background constituent concentrations, constituent concentrations from the OU4 site, statistics, scenarios for exposure to the constituents, toxicity information for the constituents, and risk equations. The following discussion presents the methodology followed to determine the risk-based PRGs associated with Solar Evaporation Pond (SEPs) soils and to determine the amount of soil requiring remediation.

The Phase I RCRA Facility Investigation/Remedial Investigation (RFI/RI) sampling and analysis results provide the data with respect to the constituent concentrations in the vicinity of OU4. Background constituent concentrations in soils are provided from the Rocky Flats Environmental Technology Site (RFETS) buffer zone (upgradient from the OU4 SEPs). These two distinct data sets were compared statistically to determine if the OU4 concentrations were significantly higher than the background concentrations. The statistical methodology used has been agreed upon and approved by the Department of Energy (DOE), the Environmental Protection Agency (EPA), and the Colorado Department of Public Health and the En-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vironment (CDPHE) for use throughout the RFETS. Statistical analysis was performed for surface soils and subsurface soils (vadose zone) separately because some constituents are contaminants in surface soils but are not contaminants in subsurface soils, and vice versa. If an OU4 constituent is statistically significantly higher than the background concentration, then it is a potential contaminant of concern (PCOC). Table 1 provides a list of the OU4 PCOCs in both surface and subsurface soils.

Contaminants that are present at high enough levels to require action are called contaminants of concern. Risk-based PRG calculations are performed to determine if an OU4 PCOC graduates to a contaminant of concern (COC). A PCOC does not become a COC unless its risk at OU4 exceeds the 1.0×10^{-6} target level. i.e., if the concentrations of a OU4 PCOC (based on the Phase I RFI/RI results) exceed the PRG concentration, then the PCOC becomes a COC. Any OU4 soils having COC concentrations ex-

TABLE 1
LIST OF THE OU4 POTENTIAL CONTAMINANTS OF CONCERN

Surficial Soil

Radionuclides
Americium-241
Cesium-134
Gross alpha
Plutonium-239,240
Tritium
Uranium-233,234
Uranium-235
Uranium-238

Metals/Inorganics
Beryllium
Cadmium
Calcium
Mercury
Nitrate/Nitrite
Silicon
Silver
Sodium

Organics
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(ghi)prylene
Benzo(k)fluorathene
Bis(2-ethylhexyl)phthalate
Chrysene
Di-n-butyl phthalate
Fluoranthene
Indeno(1,2,3-cd)pyrene
Phenanthrene
Pyrene
Aroclor-1254

Subsurface Soil

Radionuclides
Americium-241
Cesium-134
Cesium-137
Gross beta
Plutonium-239,240
Radium-226
Strontium-89,90
Tritium
Uranium-233,234
Uranium-235
Uranium-238

Metals/Inorganics
Barium
Cadmium
Calcium
Lithium
Manganese
Nitrate/Nitrite
Potassium
Sodium
Sulfide
Zinc

Organics
2-Butanone
Acetone
Bis(2-ethylhexyl)phthalate
Chloroform
Di-n-butyl phthalate
Methylene chloride
Toluene
Cyanide

TABLE 2
CALCULATED PRGs

Potential Contaminants of Concern	SURFICIAL SOILS PRG Residential	SUBSURFACE SOILS PRG Construction Worker
METALS/INORGANICS		
Barium (mg/kg)		6986.85
Beryllium (mg/kg)	0.0019	
Cadmium (mg/kg)	0.060	18.80
Cyanide (mg/kg)		4945.80
Manganese (mg/kg)		346.51
Mercury (mg/kg)	0.18	
Nitrate (mg/kg)	15815.84	317637.92
Nitrite (mg/kg)	988.49	19852.37
Silver (mg/kg)	148.27	
Strontium (mg/kg)		119114.22
Uranium (mg/kg)	1.85	61.66
Zinc (mg/kg)		63747.50
VOCs		
2-butanone (µg/kg)		47697330.79
Acetone (µg/kg)		5962196.64
Chloroform (µg/kg)		98400.00
Methylene chloride (µg/kg)		78900.00
Toluene (µg/kg)		11924342.79
SEMI VOCs		
Benzo(a)anthracene (µg/kg)	7.40	
Benzo(a)pyrene (µg/kg)	0.74	
Benzo(b)fluoranthene (µg/kg)	7.40	
Benzo(k)fluoranthene (µg/kg)	74.02	
Bis(2-ethylhexyl)phthalate (µg/kg)	2686.37	49980.44

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ceeding the PRGs requires remediation. A measure of conservatism was included in the PRG calculations by predicting the cumulative effects of the various OU4 contaminants. Cumulative individual risks were considered by dividing the target risk level ($1.0x10^{-6}$) by the number of contaminants affecting the same target organ. Therefore, in the PRG equations, if 5 contaminants affected the same target organ, then the IAG mandated acceptable risk level ($1.0x10^{-6}$) was divided by the number of contaminants effecting the organ (5) to establish an organ specific target risk level for each of those contaminants ($1.0x10^{-6}/5$ or $2.0x10^{-7}$).

PRGs were calculated separately for the surface and subsurface soils because the exposure scenarios for these soils are different. An exposure scenario is an important factor in calculating a risk-based PRG. An exposure scenario

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TABLE 2 *(continued)*
CALCULATED PRGs

Potential Contaminants of Concern	SURFICIAL SOILS PRG Residential	SUBSURFACE SOILS PRG Construction Worker
Chrysene (µg/kg)	137.39	
Di-n-butyl phthalate (µg/kg)	1735035.21	42488913.53
Fluoranthene (µg/kg)	63547.33	
Indeno(1,2,3-cd)pyrene (µg/kg)	7.40	
Pyrene (µg/kg)	35745.38	
OTHER		
Aroclor-1254 (µg/kg)	11.87	
RADIONUCLIDES		
Americium-241 (pCi/g)	0.27	1.09
Cesium-134 (pCi/g)	0.001	0.06
Cesium-137 (pCi/g)		0.16
Plutonium-239 (pCi/g)	0.38	1.16
Plutonium-240 (pCi/g)	0.38	1.16
Radium-226 (pCi/g)		0.05
Strontium-89 (pCi/g)		78.80
Strontium-90 (pCi/g)		7.42
Tritium (pCi/g)	1630.00	4950
Uranium-233 (pCi/g)	5.25	16.70
Uranium-234 (pCi/g)	5.32	16.70
Uranium-235 (pCi/g)	0.02	0.80
Uranium-238 (pCi/g)	0.077	3.86
Benzo(ghi)perylene (µg/kg)	--	
Lithium (mg/kg)		--
Sodium (mg/kg)	--	--
Phenanthrene (µg/kg)	--	

is established to identify the pathways by which humans can be exposed to PCOCs. The exposure scenario is used to develop the equations for the actual risk-based calculations. A future onsite resident was selected as the exposure scenario for the surface soils. This is a conservative exposure scenario because it assumes that the RFETS will be open to the public for a housing development at the edge of the SEPs and resident receptors are assumed to spend more time at a site than workers or individuals using the site for recreation. The fact that this exposure scenario is conservative indicates that the risk will tend to be overestimated and that additional surface soils may be included in the remediation activities than is necessary to provide the required level of protection. Under the calculated residential exposure scenario, chil-

dren and adult receptors were exposed to contaminated surface soils through incidental ingestion, dermal contact, and inhalation of windborne particulates. A construction/ remediation worker exposure scenario was selected for defining the subsurface soils that may pose a risk. This exposure scenario is not as conservative as the onsite resident scenario. The onsite resident scenario was not selected for the subsurface soils because according to the EPA's Risk Assessment Guidance for Superfund, onsite residents are not routinely exposed to the subsurface soils. Under the onsite worker exposure scenario, an adult receptor was exposed to contaminated subsurface soils through incidental ingestion, dermal contact, and inhalation of particulates that may be mobilized during construction activities. The primary difference between the onsite resident and construction/ remediation worker scenario calculations are the soils they are exposed to (surface soil for the onsite resident, and subsurface soil for the construction/remediation worker), and the length of time over which the exposure occurs (30 years for the onsite resident and 10 years for the construction/remediation worker). Risk-based PRGs were calculated for each PCOC for both exposure scenarios via standard EPA risk equations. Table 2 provides the PRGs for the PCOCs.

SOLUTION: The calculated risk-based PRGs were compared to the actual OU4 field concentrations of the PCOCs to determine the COCs. Table 3 provides the COCs for OU4. The proposed Interim Measure/Interim Remedial Action (IM/IRA) will remediate surface and subsurface soils within OU4 which have COC concentrations that exceed the risk-based PRGs.

The risk associated with the no action alternative can be estimated using the same PRG equations as previously discussed by inserting current soil concentration values and comparing the result to the 1.0×10^{-6} acceptable target risk level. The results of this analysis indicate that the risk from the radionuclide contaminants at OU4 exceed 1.0×10^{-3} (one chance in a thousand of contracting an excess cancer), and 3.0×10^{-3} (three chances in a thousand of contracting an excess cancer) from chemical COCs at the site.

The details of this analysis is discussed in Part III, Section 2 of the OU4 IM/IRA-EA Decision Document.

TABLE 3
CONTAMINANTS OF CONCERN

Surface Soils		Subsurface Soils
Beryllium	Indeno(1,2,3-cd)pyrene	Cadmium
Cadmium	Aroclor-1254	Americium-241
Benzo(a)anthracene	Americium-241	Plutonium-239
Benzo(a)pyrene	Cesium-134	Plutonium-240
Benzo(b)fluoranthene	Plutonium-239	Radium-226
Benzo(ghi)perylene	Plutonium-240	Uranium-235
Benzo(k)fluoranthene	Uranium-233	Uranium-238
Phenanthrene	Uranium-234	
Bis(2-ethylhexyl)phthalate	Uranium-235	
Chrysene	Uranium-238	